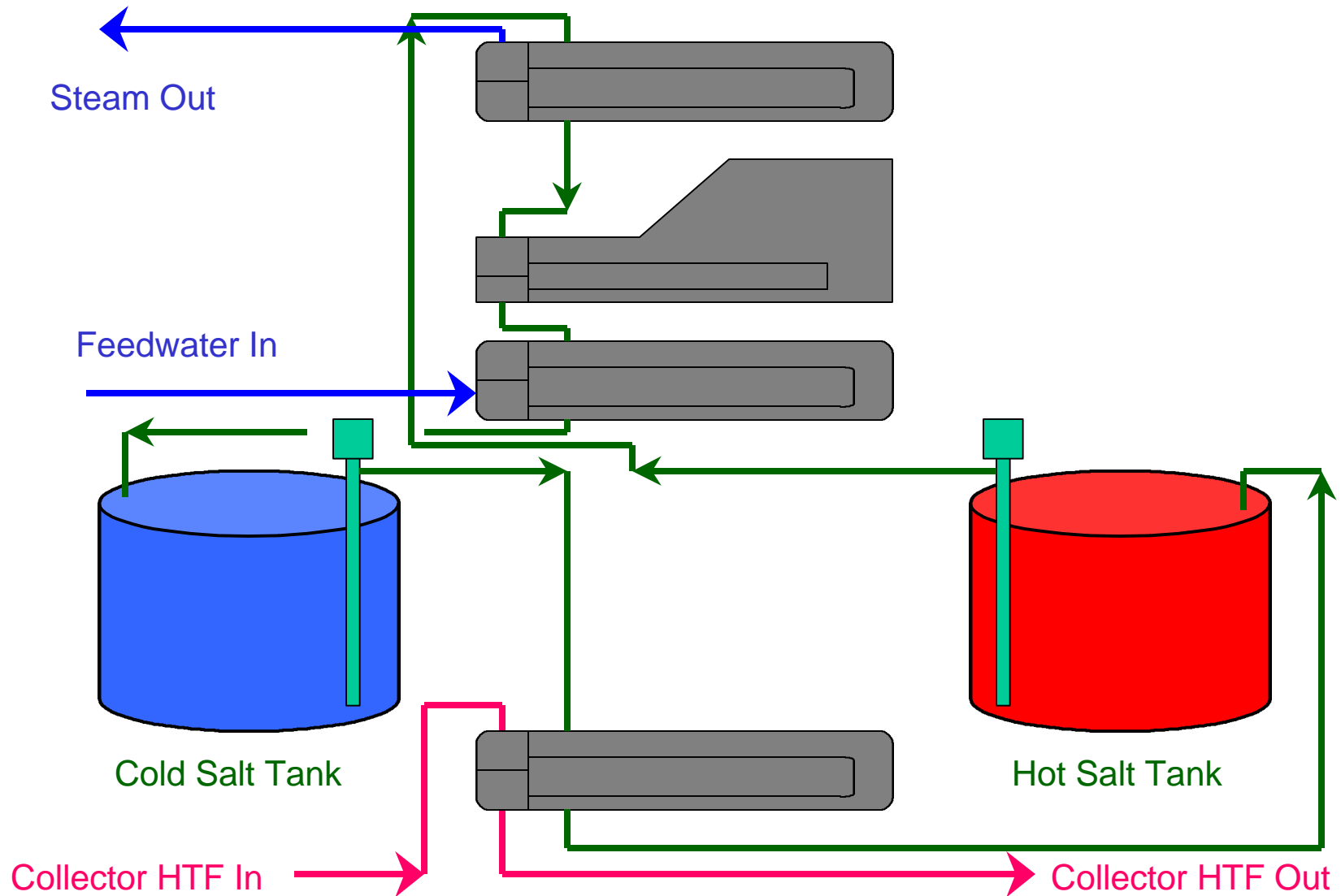


Molten Nitrate Salt for Thermal Storage with Parabolic Troughs

James Pacheco

- Features of Nitrate Salts
 - Wide Usable Temperature Range ($\Delta T \sim 300$ C)
 - Storage at Atmospheric Pressure
 - Relatively Inexpensive (\$0.18/kg)
- Drawbacks
 - High Freezing Point (cannot use for collector HTF)
 - Safety Issues of Oil-to-Salt Heat Exchanger
 - Additional Parasitic Power Consumption
 - 2nd Law Losses (Dual Media)

Schematic of Salt Thermal Storage System



Safety Issues Associated with Nitrate Salt/Oil Systems (breach of oil-to-salt heat exchangers)



*Salt and Oil Mixing Conjures Visions of
the Oklahoma City Bombing*

It is Unlikely Nitrate Salt Mixed with Therminol Would React the Same Way

From *Molten Salt Safety Study*, SAND80-8179
done by Martin Marietta:

“Motor gasoline, cracked gasoline, gas oil, and crude oil were separately mixed with sulfur and released below the surface of an open container of HITEC at 866 K (1100 F). In each case the hydrocarbon burned. ... the principal reactions were between the vaporized hydrocarbons and the air above the salt bath and not with the salt itself. ... Experimental data indicate that HITEC is not explosive. ... Draw salt or any other mixtures of sodium nitrate and potassium nitrate is expected to act similarly to HITEC.”

Real Safety Concern: Hot Volatile Hydrocarbon Mixed with Air

- A fire could start because of the presence of oxygen in the air and the hot volatile hydrocarbons.

This is NOT unique to salt, but true for any thermal storage system exchanging heat with oil and operating with an air head space.

- Engineering safety systems may be able to address that issue, e.g.:
 - VOC detectors
 - Purge head space with inert gas during emergency.

Lower Melting Point Salts

- Solar Salt (Na-K Nitrate 60:40) has a relatively high melting point (220 C)
- K-Na-Ca Nitrate Mixture
 - Eutectic mixture (46:24:30) has a melting point of 160 C
- K-Na-Li Nitrate Mixture
 - Melting points as low as 120 C. More expensive than K-Na-Ca nitrates.
- HITEC
 - 40 - NaNO_2 , 7 - NaNO_3 , 53 - KNO_3
 - Melts at 142 C
 - Require N_2 blanket.